A12 Cont.

building the plurality of possible analytic word answers with the character variants that are associated with a word in the dictionary.

REMARKS

Claims 1-28 are now pending in the present application. Claims 4-28 have been added. Claims 4-8 depend from claim 1. Claim 9 depends from claim 2. Claims 10-13 depend from claim 3. Claims 14 and 22 are added independent claims. Claims 15-21 depend from claim 14. Claims 23-28 depend from claim 22.

The specification has been amended to correct clerical errors.

The drawings have been amended as shown in red ink in the marked-up copies to add missing reference numerals and correct clerical errors. Substitute sheets 2, 3 and 6 of drawings are provided.

Applicant respectfully submits the above claim amendments for consideration. The newly added claims represent patentable subject matter disclosed in the original description, and thus, a prompt examination is respectfully requested. The Examiner is encouraged to contact the undersigned attorney by telephone with respect to any questions regarding this Preliminary Amendment.

Date: October 11, 2001

Respectfully submitted,

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AS BT 11-06-01

S/N 09/788,032 PATENT

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	Alexander Filatov, Igor Kil and Arseni Seregin	Examiner:	UNKNOWN
Serial No.:	09/788,032	Group Art Unit:	2621
Filed:	February 16, 2001	Docket No.:	40002.4-US-01
Title:	HOLISTIC-ANALYTICAL RECOGNITION OF HANDWRITTEN TEXT		

MARKED-UP VERSION OF THE SPECIFICATION AND DRAWINGS PURSUANT TO 37 C.F.R. §1.121

Please replace the paragraph beginning on page 4, line 7 and ending on page 4, line 13 with the following paragraph:

> In one embodiment of the invention depicted in **FIG. 1**, a load image module **100** provides a digitized representation of an input string of characters to be recognized. The string of characters is most typically a word, but might be a plurality of words making up a phrase. The string of characters are alphanumeric characters, and thus might be mixed as numbers and words in a phrase. While "word" will be used throughout to represent the character string being recognized, it should be understood that the character string might be a mix of alphanumeric characters, [might be] a plurality of words, [might be] or a phrase.

Please replace the paragraph beginning on page 6, line 25 and ending on page 7, line 2 with the following paragraph:

> Device **200** may also have input device(s) **214** such as keyboard, mouse, pen, voice input device, touch screen input device, document scanners, etc. Output device(s) **216** such as a display, speakers, printer, electro-mechanical devices, such as document handlers, controlled by device **200,** may also be included. All these devices are well know in the art and need not be discussed at length here. The particular input/output device working with the computing device **200** will

depend on the application in which the recognition system is working and whether the recognition is system is working offline or online with cursive images being recognized.

Please replace the paragraph beginning on page 7, line 3 and ending on page 7, line 16 with the following paragraph:

With the computing environment in mind, another embodiment of the invention is shown in **FIG. 3**. In this embodiment, the combined holistic-analytic recognition technique is divided into a holistic phase, a segmentation phase, an analytic phase and a merge phase. Again, an image of a word is loaded into the computing system by the load operation **302.** The image might be loaded by scanning a handwritten document or by detecting a word entered on a touch screen with a stylus. The load operation **302** digitizes the cursive word image and passes it to the identify features module **304** and to the translate module **306.** The identify features module **304** breaks the word image into character features, i.e. portions of a character that may be used to recognize the word. Accordingly, the output of the identify features module **304** is a string of character features for the entire word, or in the case of the Guberman et al patent, a string of metastrokes. Another output from the identify features module **304** [is the] is the position of each feature relative to the word image. In the example of metastrokes, the features list **312** would contain, for the input word image, the string of metastrokes for the input word and the position of the metastrokes along the digitized image of the word.

Please replace the paragraph beginning on page 7, line 17 and ending on page 7, line 27 with the following paragraph:

In the matching operation **308** the string of input character features from feature list **312** is matched against prototype features for words in a vocabulary provided by a lexicon of words **310.** Lexicon, or dictionary, **310** may be tailored to an expected vocabulary for the input words to be recognized. The words in the lexicon are stored in ASCII character form. The words in ASCII character form from lexicon **310** are converted by convert operation **309** into a string of

prototype character features. A plurality of sets of prototype character features for various shapes of each ASCII character is stored as prototype character features **307**. Convert operation **309** retrieves one or more prototype character feature sets for each character in a word from lexicon **310** and passes the string of prototype character features for the reference word to the matching operation **308.** If the character features are metastrokes, a prototype string of metastrokes is then compared against the input string of metastrokes received from identify operation **304** for the input word.

Please replace the paragraph beginning on page 8, line 17 and ending on page 8, line 24 with the following paragraph:

Locate operation **314** then locates the character segmentation points between input metastrokes from the correspondence of the input and prototype metastrokes. Since the character segmentation locations between metastrokes are known for the string of prototype metastrokes, this information is applied to the correspondence between the input and prototype metastrokes to detect the segmentation points in the string of input metastrokes. Thus, the output of the locate operation **314** is the character segmented feature list **316** which has a string of character features for each answer in the holistic answer list **311,** and features are segmented into character sets for each character in the answer.

Please replace the paragraph beginning on page 11, line 10 and ending on page 11, line 17 with the following paragraph:

FIG. 6 illustrates an alternative embodiment for finding the best answer. In FIG. **6** the operations begin at retrieve operation **602** and retrieve operation **604**. Retrieve operation **602** retrieves the best analytic answer from the analytic answer list **108** (FIG. 1) or **328** (FIG.3). The best answer on each list will be the answer with the highest confidence value. Retrieve operation **604** retrieves the best holistic answer from the holistic answer list **106** (FIG. 1) or **311** (FIG. 3). The best analytic answer and the best holistic answer are passed to select operation **606**. Select operation **606** uses any well known probability algorithm to choose

the analytic or holistic answer as the best answer **608**. The best answer plus its confidence [**612**] 608 is the result of the select operation **606.**

Please replace the paragraph beginning on page 12, line 18 and ending on page 12, line 27 with the following paragraph:

FIG. 8 illustrates an operational flow for another embodiment for the analytical recognition module **320** in **FIG. 3**. In **FIG. 8**, neural character recognition recognizes all possible character variants for all possible segmentation hypothesis based on the cutout images of character segmented words **318**. In effect all possible ASCII words (legitimate or otherwise) are collected in candidate ASCII words list **804**. When test operation [**804**] 806 detects that all possible character variants for all possible segmentation hypotheses have been recognized, then word filter **808** operates to select legitimate word answers. Filter **808** uses the vocabulary dictionary **810** to pass to the analytic ASCII word answer list **328** only those candidate words from list **804** that have a counterpart word in the vocabulary dictionary **810**. Again the confidence value is determined in the same manner as just discussed above for **FIG. 7**.

Please replace the paragraph beginning on page 3, line 1 and ending on page 3, line 9 with the following paragraph:

The invention may be implemented as a computer process, a computing system or as an article of manufacture such as a computer program product or computer readable media. The computer program product or computer readable media may be a computer storage medium readable by a computer system and encoding a computer program of instructions for executing a computer process. The computer program product or computer readable media may also be a propagated signal on a carrier readable by a computing system and encoding a computer program of instructions for executing a computer process.

Please replace the paragraph beginning on page 6, line 25 and ending on page 7, line 2 with the following paragraph:

Device **200** may also have input device(s) **214** such as keyboard, mouse, pen, voice input device, touch screen input device, document scanners etc. Output device(s) **216** such as a display, speakers, printer, electro-mechanical devices, such as document handlers, controlled by device **200,** may also be included. All these devices are well know in the art and need not be discussed at length here. The particular input/output device working with the computing device **200** will depend on the application in which the recognition system is working and whether the recognition [is] system is working offline or online with cursive images being recognized.

Please replace the paragraph beginning on page 8, line 4 and ending on page 8, line 16 with the following paragraph:

After the matching operation for each answer, it is possible to construct a character segmented feature list. The constructing operation includes a back track operation **313** and a locate operation **314**. The back track operation **313** traces back through the decision operations performed by matching operation **308** in matching the strings of metastrokes. As the decisions are traced, back track operation **313** associates each input metastroke with a corresponding prototype metastroke. The decision operations may be graphed as a matching path through a matching graph matrix where as in the [Gurberman] Guberman et. al patent, the matching graph ordinates are the prototype metastrokes and the input metastrokes. This matching technique and the matching graph is also described in an article entitled "Handwritten Word Recognition - The Approach Proved by Practice" by G. Dzuba, A. Filatov, D. Gershuny, and I. Kil, (Proceedings IWFHR-VI, August 12-14, 1998, Taejon, Korea, pp. 99-111. A matching decision, [that] which moves the recognition process forward in the matching graph, is a move diagonally through the graph. Each of these diagonal moves effectively identifies a correspondence between an input metastroke and a prototype metastroke.

Please replace the paragraph beginning on page 10, line 12 and ending on page 10, line 20 with the following paragraph:

Fill detect operation **408** detects segmentation points between characters by detecting the point [of] at which filling between metastroke features meets for those adjacent features from adjacent segmented feature sets. In other words, if two adjacent metastrokes are located in different character metastroke sets, then the meeting point for filling the digitized image between those adjacent metastrokes will be detected as a segmentation point between the characters represented by the metastroke sets. After each of these segmentation points is determined between the character feature sets, segment operation **410** cuts the word image at each of the segmentation points. Cutting the word image at the segmentation points provides the character cutout images **318** used in analytic recognition phase for the word. This completes the operations of the translate module **306** in **FIG. 3**.

Please replace the paragraph beginning on page 10, line 21 and ending on page 10, line 30 with the following paragraph:

FIG. 5 illustrates one embodiment for the find operation **110** or the merge or best answer phase in **FIG. 3**. In **FIG. 5**, the best answer operations begin at operation **502** which compares answers from the analytic answer list and the holistic answer list to find matches. When the same answer is on both lists, list operation **504** lists the matching answers with a combined value for their confidence. The combined value might simply be the average of the two confidence values. Alternatively the confidence in answers on each list might be weighted and combined. Where an answer is only on one list, it is possible to still add that answer on the matching answer list, by averaging [its] the confidence value associated with the answer with a second confidence value of zero or weighting [it's] the confidence value to reflect the fact that it was only on one list. For extremely high confidence values for a single answer, this might still provide a significant answer on the answer list of matching answers.

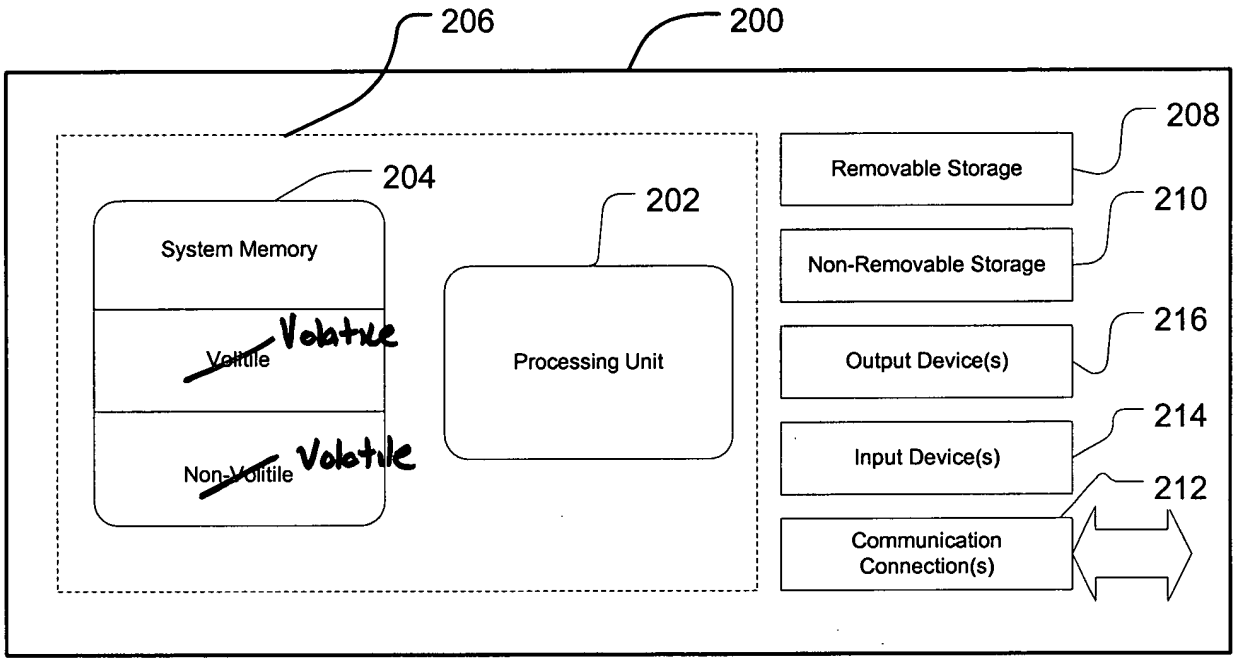
206
200
208
204
202
210
System Memory
Removable Storage
Non-Removable Storage
Volatile
Volatile
216
Processing Unit
Output Device(s)
214
Input Device(s)
Non-Volitile
Volatile
212
Communication Connection(s)

FIG. 2

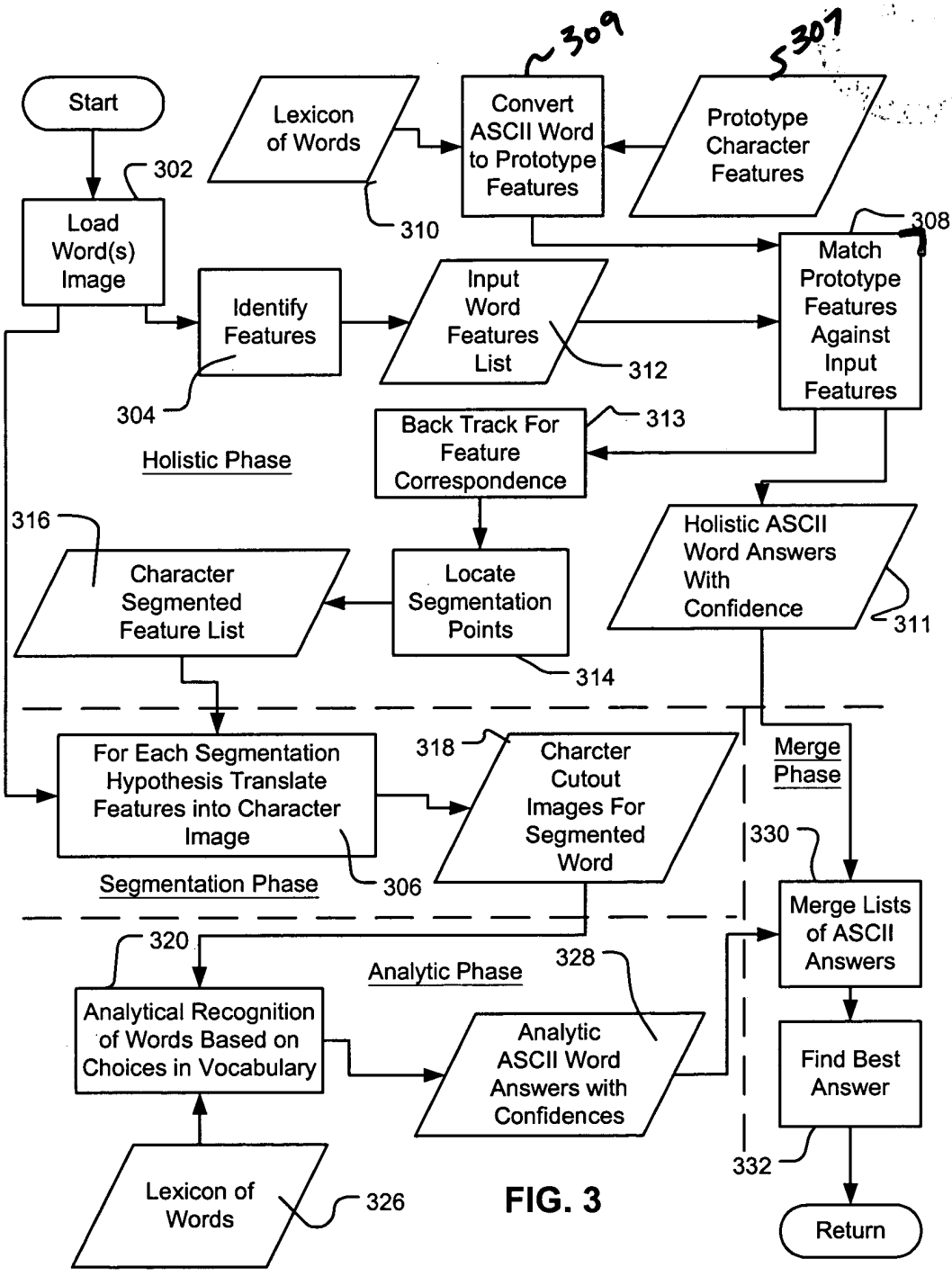
Start
Lexicon of Words
Convert ASCII Word to Prototype Features
Prototype Character Features
309
307
302
Load Word(s) Image
310
308
Match Prototype Features Against Input Features
Identify Features
Input Word Features List
312
304
Holistic Phase
Back Track For Feature Correspondence
313
316
Character Segmented Feature List
Locate Segmentation Points
Holistic ASCII Word Answers With Confidence
311
314
Merge Phase
For Each Segmentation Hypothesis Translate Features into Character Image
318
Charcter Cutout Images For Segmented Word
330
306
Segmentation Phase
Merge Lists of ASCII Answers
320
328
Analytic Phase
Analytical Recognition of Words Based on Choices in Vocabulary
Analytic ASCII Word Answers with Confidences
Find Best Answer
332
Lexicon of Words
326
Return

FIG. 3

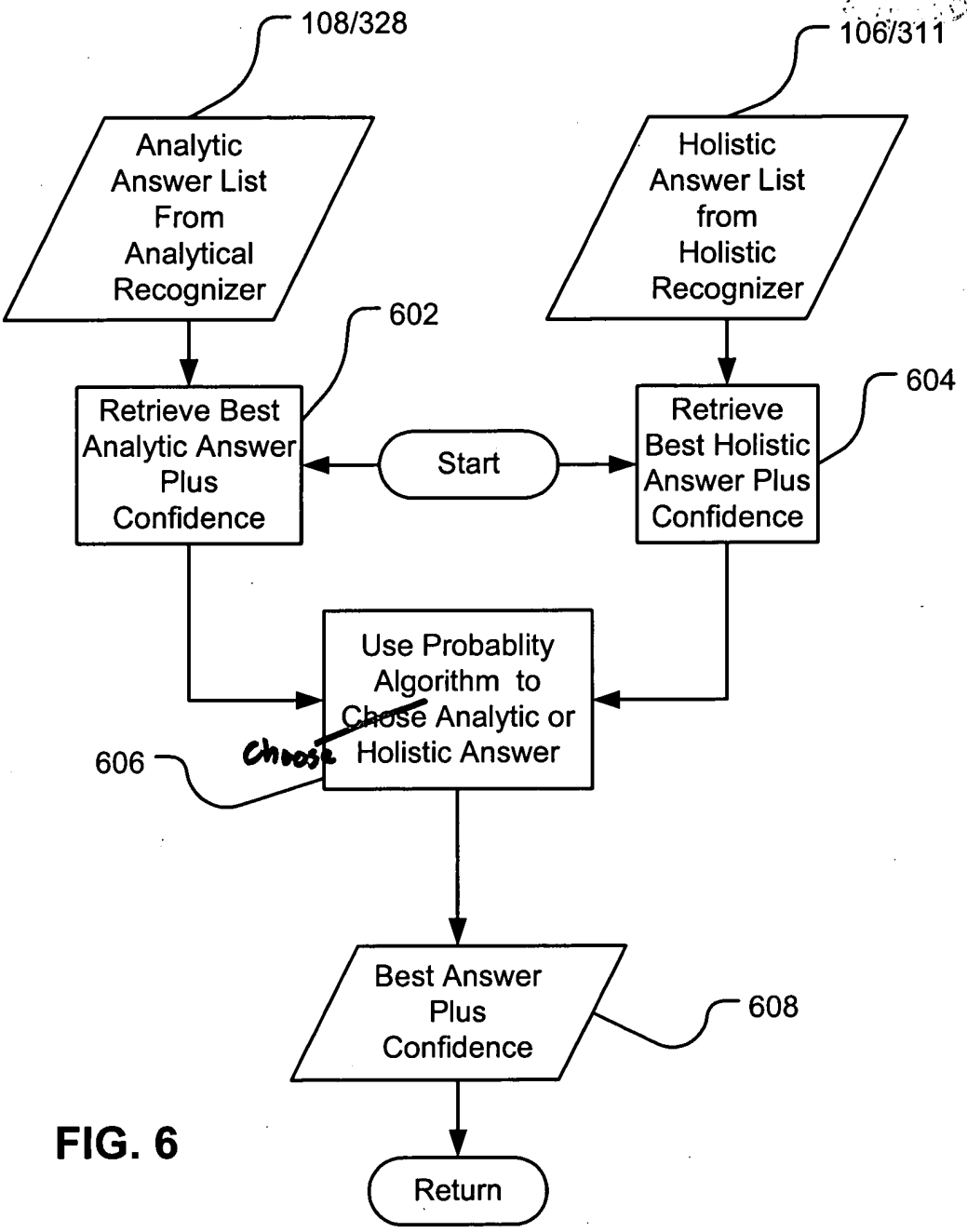
108/328
106/311
Analytic Answer List From Analytical Recognizer
Holistic Answer List from Holistic Recognizer
602
604
Retrieve Best Analytic Answer Plus Confidence
Start
Retrieve Best Holistic Answer Plus Confidence
Use Probablity Algorithm to Chose Analytic or Holistic Answer
Choose
606
Best Answer Plus Confidence
608
Return

FIG. 6